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(54) Subminiature fuse

(57) A subminiature fuse has a housing (12, 14) in which two or more enclosed arc-extinguishing chambers (18, 20, 44) are provided in series with partitions (36, 40), the chambers communicating by means of small holes (16) in the respective partitions. A pair of lead terminals (22, 24) is fixed to the housing in such a manner that the respective fuse wire connecting portions (30, 32) of the lead terminals are accommodated in the respective opposite end arc-extinguishing chambers and the portions (26, 28) of the lead terminals for connection with an external circuit project out of the housing. A fuse wire (34) extends between the fuse wire connecting portions (30, 32) of the pair of lead terminals through the small holes in the respective partitions. The fuse does not contain arc-extinguishing material.

Fig. 3

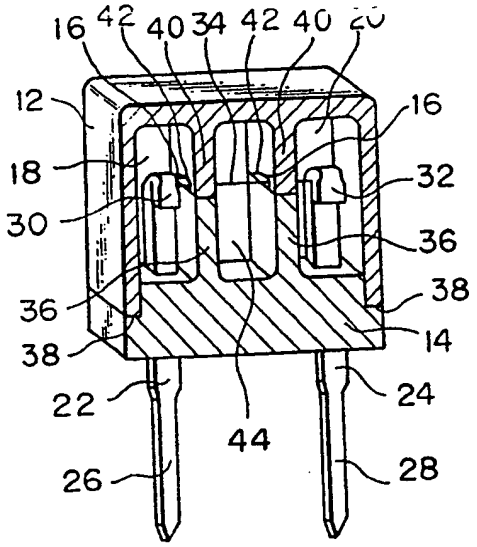

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Fig. 1

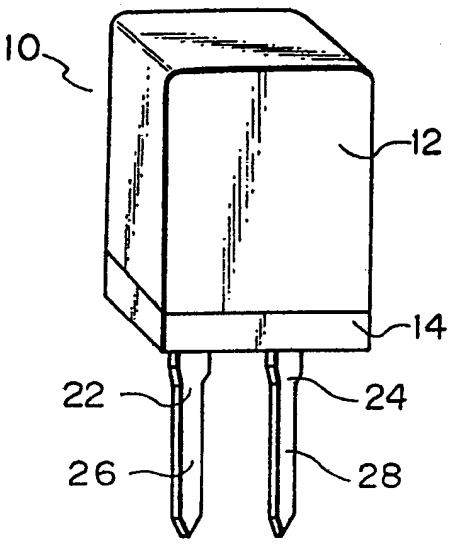

Fig. 2

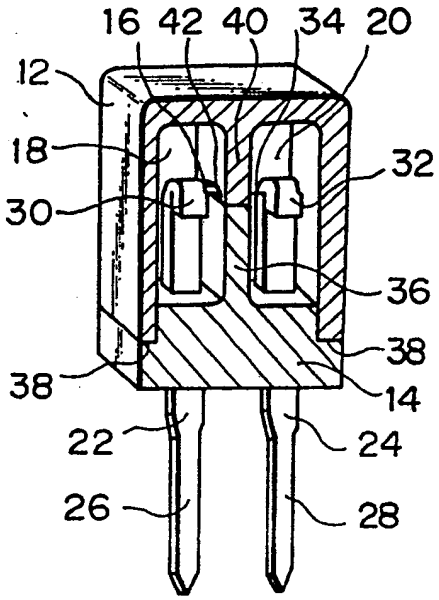

Fig. 3

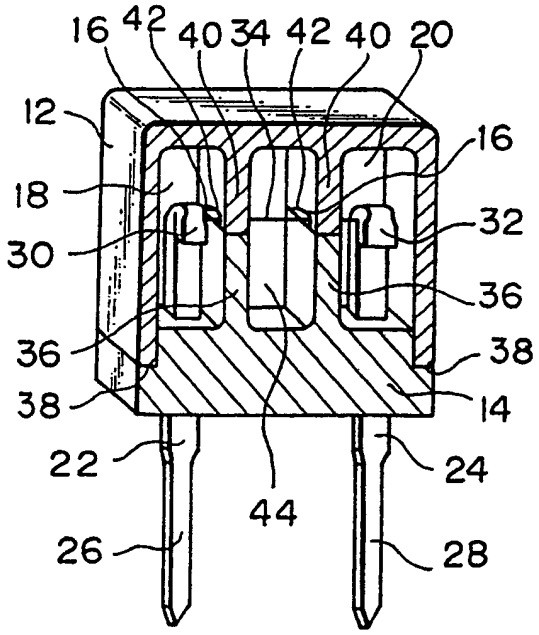

Fig. 4

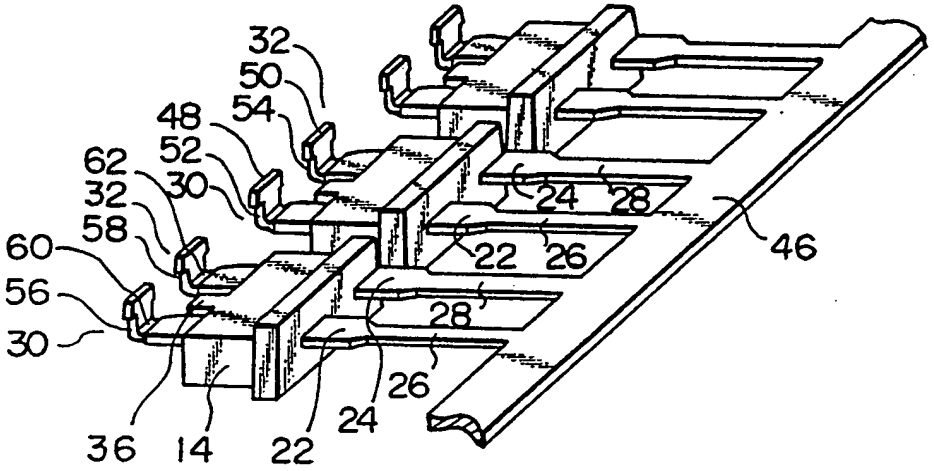
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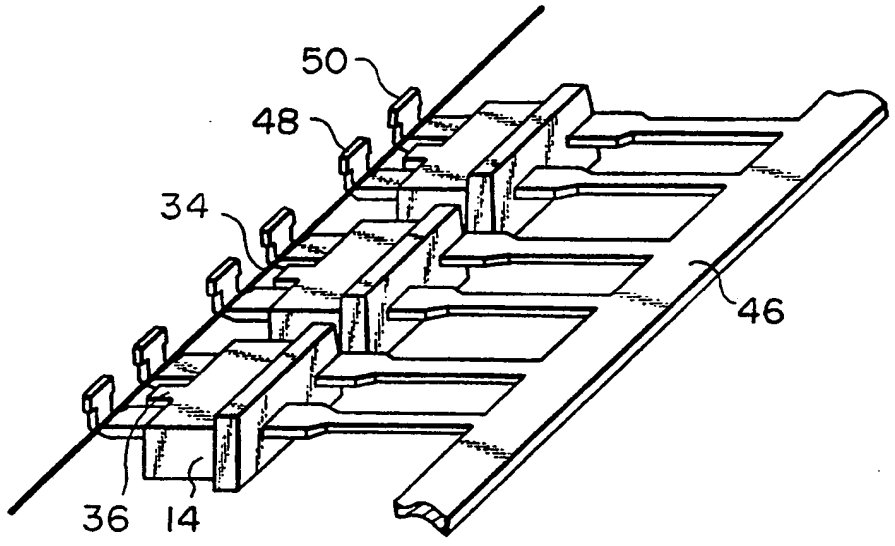
Fig. 5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SUBMINIATURE FUSE AND METHOD OF MANUFACTURING SAME

The present invention relates to a subminiature fuse.

In recent years, electronic appliances have become increasingly miniaturized and as a consequence, electric components constituting an electric circuit, for example, are also being considered for further miniaturization. Furthermore, in connection with withstand voltage, a high potential such as 200 V wiring is gradually becoming commonly accepted for household use and as a result miniature fuses which can be used in a range from a low voltage such as a few volts required for printed circuit boards to a high voltage exceeding AC 125 V are increasing in demand. Various sorts of miniature fuses have been developed in order to satisfy these requirements. As an example of miniature fuses which have been developed so far, there is available a type having the fuse wire completely embedded in resin to thereby easily attain miniaturization. However, a fuse of this sort suffers from drawbacks such that in the case of a relatively small overcurrent flowing therethrough due, for example, to failure of a transistor, Joule heat may be absorbed by the resin encircling the fuse wire resulting in a delay in the fusion time or the fuse may not melt until a sufficient number of elements are damaged to cause a flow of overcurrent high enough to melt the fuse. When a large current of a voltage exceeding AC 125 V is caused to flow due to short-circuiting or the like, since the fuse wire

is entirely surrounded by resin, there is therefore nowhere room for metallic vapor generated by the melted, vaporized and expanded metallic component by the large current to be released. In consequence, the arcing time may be prolonged and the resin surrounding the fuse wire may be caused to shatter and scatter, thus causing potential hazard. In order to solve the problems as pointed out above, a miniature fuse has been developed wherein the area surrounding the fuse wire is filled with an arc-extinguishing material to thereby prevent the resin from being fractured by a large current. However, in the same manner as in the fuse as earlier mentioned, Joule heat may be absorbed by the arc-extinguishing material in the case of a small overcurrent and in this sense the problem that the fuse wire may not be melted away unless an excessively large current is caused to flow could not be entirely solved and the developed miniature current fuse as mentioned above was still not reliable.

Accordingly, an object of the present invention is to provide a subminiature fuse which is capable of solving the general problems as mentioned above, being very small in size nevertheless employing no arc-extinguishing material, providing a high breaking characteristic, protecting the relative circuit and components when an abnormal current flows, by quickly melting away the fuse wires and having less variation in fusion time thus being reliable.

Further object of the present invention is to provide a method of manufacturing a subminiature fuse mentioned above.

The object of the present invention can be attained by such a subminiature fuse as comprising a housing having therein two enclosed arc-extinguishing chambers adapted to extinguish arc and having also a small hole adapted to communicate the two arc-extinguishing chambers with each other, a pair of conductive terminal members secured to the housing and having opposite end portions, the end portions of the pair of terminal members extending outwardly from the outer surface of the housing so as to define the external connection adapted to be connected to an external electric circuit and the other end portions of the pair of terminal members extending internally respectively into the two arc-extending chambers in the housing and a fusible element having opposite end portions and adapted to be respectively electrically and mechanically coupled to the other end portions of the pair of terminal members, whereby the circuit can be broken by extinguishing arc without using arc-extinguishing material and variation of the pre-arcing time-current characteristics of the fuse can be reduced.

According to a preferred embodiment of this invention, the housing comprises an upper member having a concave and a partition partitioning the concave, and a lower member. The pair of conductive terminal members are secured to the lower member, the end portions of the pair of terminal members extending outwardly from the lower surface of the lower member to define the external connecting portion to be connected to an external electric circuit, the other end portions of the pair of terminal members extending from the upper surface of the lower member. The lower member is

provided with a partition projecting upwardly from the upper surface of the lower member so as to partition the pair of terminal members. When the upper member is combined with the lower member with the concave facing downwardly to the upper surface of the lower member, the partition of the upper member is aligned with and abutted against the partition of the lower member to define the two enclosed arc-extinguishing chambers respectively accommodating each of the other end portions of the pair of terminal members and the small hole is provided at the partition constructed by the partitions of the upper and lower members so that the fusible element is allowed to pass through the small hole.

A lead frame is prepared by press working, the lead frame having a comb-like configuration in which the ends of a plurality of terminal members are successively connected to the tip end portions of the respective teeth of the comb-like configuration. Each set of terminal members provided in the lead frame are secured to the lower member, each set comprising two terminal members, when the lower member is formed of resin by molding. At the tip ends of a series of terminal members projecting from the upper surface of the lower member, there is extended an elongated fuse wire. The tip end portions of the terminal members are then folded in a manner to hold the fuse wire and subsequently firmly soldered therewith. Then the fuse wire is cut at the portion located between the adjacent terminal members of the respective adjacent sets of the terminal members. The upper member having a small semicircular recess at the center of the tip end of the partition is combined with the lower

member at the side of the fuse wire being fixed to the lower member, and the abutting portions of the upper and lower members are welded together by means of ultrasonic welding. The tip ends of the partitions of the upper member and the lower members are welded, and the tip ends of the side walls defining the concave in the upper member, and the lower member are welded together, whereby two arc-extinguishing chambers are formed so as to respectively accommodate the end portions of the pair of terminal members fixing the fuse wire. The fuse wire extended between the tip end portions of the pair of terminal members is held in a floating condition in the small semicircular recess portion provided at the partition of the upper member without contacting the partitions of both upper and lower members. With this arrangement, Joule heat will not be absorbed upon occurring overcurrent and the fuse wire can be melted away quickly. Even if, after the fuse wire has been melted away, arc may be generated, the metallic vapor which likely generates arc will be confined in the small hole constructed by the small semicircular recess. In this way, it is difficult for the arc to be splashed between the terminal members and thus arc-extinguishing can be facilitated. Furthermore, the partition which partitions these two arc-extinguishing chambers serves to split the arc, so that the dielectric strength between the terminal members can be enhanced and restriking of arc can be reduced. And upon completion of welding the upper and lower members, the ends of the terminal members at the side of the terminal members connected to the teeth of the comb-like configuration

are cut to provide individual fuses.

According to another embodiment of this invention which provides a fuse preferable for use for the voltage equal to or exceeding AC 125 V, the distance between the terminal members as described in connection with the fuse mentioned above is made twice as long and one or more than one arc-extinguishing chambers are provided between the two arc-extinguishing chambers each of which accommodates one end portion of the pair of terminal members fixing the fuse wire so as to provide a higher breaking capability. It may be understood that since the comb-like lead frame having the terminal members connected in series is used for assembling the fuse, the steps of securing the terminal members to the lower member by molding, fixing the fuse wire to the tip end portions of the terminal members and welding the upper and lower members can be executed successively so that low cost mass-production can be attained.

These and further objects and advantages of the present invention may become apparent through reading the description in reference to the accompanying drawings and the novelty as pointed out in the appended claims.

Fig. 1 is a perspective view of a subminiature fuse according to an embodiment of the present invention;

Fig. 2 is a cross-sectional view of the subminiature fuse shown in Fig. 1 with a portion being cut away;

Fig. 3 is a cross-sectional view of a subminiature fuse according to another embodiment of the present invention with a portion being cut away; and

Fig. 4 and Fig. 5 illustrate a manner of assembling the subminiature fuse shown in Fig. 1 through Fig. 3 according to the embodiments of the present invention.

An embodiment of the present invention will now be described by referring to Figs. 1 and 2. Fig. 1 is a perspective view of an embodiment of a subminiature fuse according to the present invention. The subminiature fuse is of a very compact construction having the size of approximately 5 mm (longitudinal × lateral) and approximately 6.5 mm (height).

Fig. 2 is a cross-sectional view of the subminiature fuse shown in Fig. 1 with a portion cut away to clearly show the internal construction thereof.

Referring to Figs. 1 and 2, the housing 10 consists of the upper member 12 and the lower member 14. As explained in more detail, when these two members are combined, two arc-extinguishing chambers 18, 20 are defined in the housing 10, the chambers being communicated with each other through a small hole 16. A pair of lead terminals 22, 24 made of conductive material are embedded in the lower member 14 made of electrically insulating material. One ends of the lead terminals 22, 24 are projected from the lower side surface of the lower member 14 to provide the external connections 26, 28 adapted to be connected to the external electrical circuit, while the other ends of the lead terminals 22, 24 are projected from the upper side surface of the lower member 14 to provide the portions 30, 32 for connecting the fuse wire at the tip ends. The fuse wire 34

is stretched between the fuse wire connecting portions 30, 32 of a pair of the lead terminals 22, 24. The opposite ends of the fuse wire 34 are electrically connected to the fuse connecting portions 30, 32 and mechanically secured thereto. The fuse wire connecting portions 30, 32 are preferably so constructed that the tip end portions are folded to hold the opposite end portions of the fuse wire thereby and then are firmly secured by soldering therebetween. The lower member 14 has the partition 36 which is projected upwardly from the central portion of the upper surface of the lower member 14 to partition the fuse wire connecting portions 30, 32 of the lead terminals 22, 24 and whose tip end surface extends to the height slightly lower than the height of the stretched fuse wire 34, so as not to touch the fuse wire 34. A stepped portion 38 is provided at the side surface of the lower member 14. It is preferable that the lower member 14 is formed of resin by molding and at the same time the central portions of the lead terminals 22 and 24 are embedded in the lower member 14.

The upper member 12 includes a concave and a partition 40 extending downwardly from the top inner surface of the concave to partition the concave into two parts. A small recess 42 whose shape is semicircular in section is provided centrally at the tip end surface of the partition 40. When the upper and lower members 12, 14 are combined with the concave of the upper member 12 facing toward the side of the lower member 14 on which the fuse wire connecting portions 30, 32 of the lead terminals 22, 24 are projected, the tip ends of the side walls defining the

concave of the upper member 12 are fit against the stepped portion 38 and the partition 40 of the upper member 12 is aligned with the partition 36 of the lower member 14, so that the tip end surfaces of both partitions 36, 40 may abut with each other. The upper member 12 is constructed in this manner. After the upper member 12 and the lower member 14 are combined in the manner as explained above, the tip end of the side walls defining the concave of the upper member 12, and the stepped portions 38 of the lower member 14 as well as the abutted surfaces of the partitions 36, 40 of the upper member 12 and the lower member 14 are welded together by means of ultrasonic welding. In this way, there are provided the arc-extinguishing chambers 18, 20 adapted to accommodate each of the fuse wire connecting portions 30, 32 of the lead terminals 22, 24, and a small hole 16 of semi-circular configuration in section is formed by the recess 42 of the upper member 12 and a part of the tip end surface of the partition 36 of the lower member 14. The fuse wire 34 extends through the small hole 16 without contacting the inner wall of the hole 16 and is held in a floating condition. Owing to the construction as described above in which the fuse wire 34 is held in a floating condition without entirely contacting the upper member 12 and the lower member 14, even when a slight abnormal current flows through the fuse wire 34, Joule heat may not be absorbed by the upper member 12 and the lower member 14, so that the fuse may be quickly melted and severed so as to safely protect the external components and circuit from abnormal current. Furthermore, even if a large current exceeding AC 125 V

causes arc, such arc may be split by the partition made up of the partitions 36, 40 of the upper member 12 and the lower member 14 so that the dielectric strength may be enhanced and a high breaking capability may be attained.

Fig. 3 is a cross-sectional view of a subminiature fuse to be used for the circuit using a voltage over AC 125 V. Similar components to those explained with reference to Fig. 2 are denoted with the same numerals. The difference compared to the embodiment shown in Fig. 2 resides in that another arc-extinguishing chamber 44 is disposed between two partitions for the arc-extinguishing chambers 18, 20 adapted to accommodate each of the fuse wire connecting portions 30, 32 of the lead terminals 22, 24, whereby a higher breaking capability may be further attained.

Figs. 4 and 5 illustrate a part of steps of assembling the fuse according to the above-mentioned embodiment of the present invention. A lead frame 46 which has a comb-like configuration in which the external connecting portions 26, 28 of a plurality of lead terminals 22, 24 are connected in series at the tip ends of the respective teeth of the lead frame 46 of a comb-like configuration is firstly prepared by pressing work. The tip ends 48, 50 of the fuse wire connecting portion 30, 32 adapted to securely fasten the fuse wire 34 of the lead terminals 22, 24 are folded in "L"-shaped condition in advance by the pressing work. The opposite sides of the bending portions 52, 54 are provided with narrowed portions 56, 58 to facilitate folding work. At the central location of these narrowed portions 56, 58,

there are formed grooves 60, 62 which are provided so as to protect the fuse wire 34 from being damaged when the L-shaped tip ends 48, 50 of the fuse wire connecting portions 30, 32 are folded around the fuse wire 34 and pressed to contact with the fuse wire 34. The L-shaped bending portions 52, 54 are bent in "U" configuration to hold the fuse wire 34 therein after accommodating the fuse wire 34 and firmly fixed by soldering applied thereon. Stretching, fixing and assembling of the fuse wire 34 may be executed by using a continuous lead frame, whereby mass-production may be attained. Subsequently, the respective portions 64 of the fuse wire 34 extended between the terminal members which are fixed by molding respectively to the adjacent lower members are cut down. The upper member 12 is fit with the lower member 14 with the concave of the upper member 12 facing toward the side of the lower member 14 where the fuse wire 34 is fixed and the abutting portions of the upper member 12 and the lower member 14 are welded together by ultrasonic welding. Then, the ends of the external connecting portions 26, 28 of the terminal members 22, 24 continuously connected to the comb teeth of the lead frame 46 of comb-like configuration are severed to provide individual fuses.

Instead of providing the recess 42 on the partition 40 of the upper member 12, the recess may be provided on the partition 36 of the lower member 14 or on both partitions 36, 40 of the lower and upper members 14, 12.

As explained above, the present invention is capable of providing excellent fusion characteristics with high

breaking capability at a high voltage more than AC 125 V and less variable fusion time by providing arc-extinguishing chambers and also capable of attaining mass-production.

CLAIMS:

1. A subminiature fuse comprising:

a housing having therein two enclosed arc-extinguishing chambers adapted to extinguish arc and a small hole communicating said two arc-extinguishing chambers with each other;

a pair of conductive terminals members secured to said housing and having opposite end portions, the end portions of said pair of terminal members extending outwardly from the outer surface of said housing to define the external connecting portions to be connected to an external electric circuit and the other end portions of said pair of terminal members extending respectively into said two arc-extinguishing chambers of said housing; and

a fusible element having opposite end portions, extending through said small hole provided in said housing, the opposite end portions of said fusible element being electrically and mechanically connected respectively to said other end portions of said pair of terminal members,

whereby the circuit can be broken by extinguishing arc without using arc-extinguishing material and variation of the breaking characteristic of the fuse can be reduced.

2. A subminiature fuse as claimed in Claim 1 wherein said fusible element extends through said small hole in a manner to be spaced from the inner wall of said small hole.

3. A subminiature fuse as claimed in Claim 1 wherein one or more than one enclosed arc-extinguishing chambers are additionally disposed in series between said pair of arc-extinguishing chambers in said housing, said additional one

or more than one arc-extinguishing chambers are communicated with said pair of arc-extinguishing chambers in series via said small holes and said fusible element extending through said additional one or more than one arc-extinguishing chambers and said small holes.

4. A subminiature fuse as claimed in Claim 3 wherein said fusible element extends in a manner to be spaced from the inner wall of said small holes.

5. A subminiature fuse as claimed in Claim 1 wherein said housing is made of resin and said pair of terminal members are secured to said housing by molding said housing.

6. A subminiature fuse as claimed in Claim 1 wherein said housing includes an upper member and a lower member to which said pair of terminal members are secured and which has a partition partitioning said other end portions of said pair of terminal members;

said upper member having a concave and a partition partitioning said concave, and when said upper member and said lower member are combined with each other, said partition of said upper member is so constructed as to be aligned with the partition of said lower member and abut against the partition of said lower member; and

said partition of said upper member includes a recess provided on the surface of said partition in abutment with the partition of said lower member so as to form said small hole communicating said pair of arc-extinguishing chambers and allowing said fusible element to extend therethrough.

7. A subminiature fuse as claimed in Claim 6 wherein said fusible element extends in a manner to be spaced from

the inner wall of said small hole.

8. A subminiature fuse as claimed in Claim 6 wherein the sectional shape of said recess is semicircular.

9. A method of manufacturing a subminiature fuse comprising:

a lower member having an upper surface and a lower surface;

an upper member having a concave and a partition partitioning said concave;

a pair of conductive terminal members having opposite end portions; and

a fusible element having opposite end portions;

said pair of terminal members being secured to said lower member, the end portions of said pair of terminal members extending outwardly from said lower surface of said lower member to define the external connecting portion to be connected to an external electric circuit, the other end portions of said pair of terminal members extending from said upper surface of said lower member;

said fusible element extending between said other end portions of said terminal members, the opposite end portions of said fusible element being connected electrically and mechanically to said other end portions of said fusible element;

said lower member having a partition projecting upwardly from the upper surface of said lower member so as to partition said pair of terminal members;

when said upper member is combined with said lower member with said concave facing downwardly to the upper

surface of said lower member, the partition of said upper member is aligned with and abutted against the partition of said lower member to define two enclosed arc-extinguishing chambers respectively accommodating each of the other end portions of said pair of terminal members; and

the partition constructed by the partitions of said upper member and said lower member includes a small hole which is provided thereon such that said fusible element is allowed to pass through said small hole, said method comprising the steps of:

preparing by pressing a lead frame having a comb-like configuration in which the ends of a plurality of terminal members are successively connected to the tip end portions of the respective teeth of said comb-like configuration;

securing to said lower member each set of terminal members provided on said lead frame, each set comprising two terminal members, when said lower member is molded;

extending an elongate fusible element on the end portions of a series of terminal members provided at said lead frame and connecting said elongate fusible element electrically and mechanically to said end portions of the series of terminal members;

severing said elongate fusible element extended between the terminal members of the adjacent sets;

combining said upper member and said lower member and fixing them; and

severing the ends of said terminal members connected to said lead frame.

10. A subminiature fuse substantially as described herein with reference to and as illustrated in Figures 1 and 2, 4 and 5 of the accompanying drawings.

11. A subminiature fuse substantially as described herein with reference to and as illustrated in Figures 3, 4 and 5 of the accompanying drawings.